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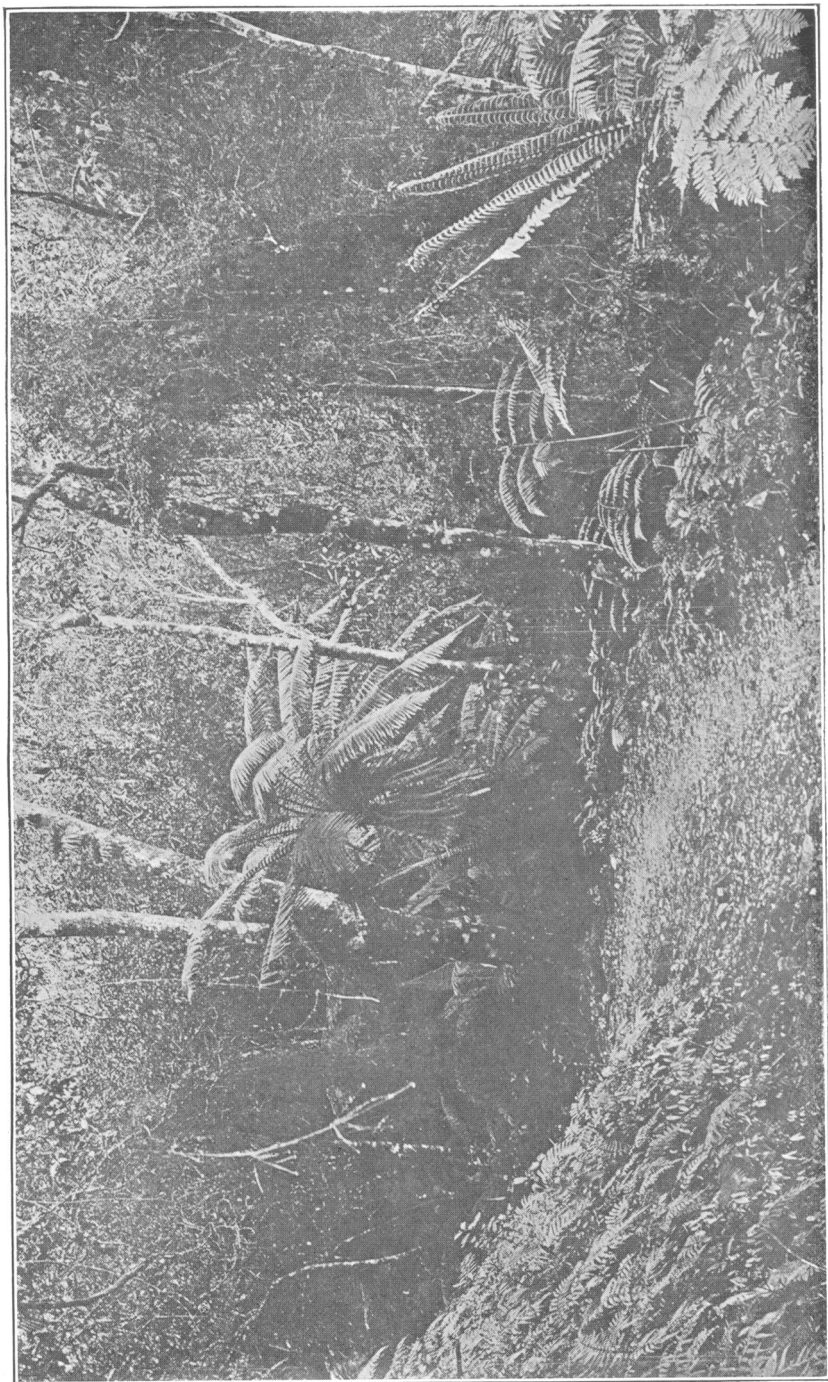
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THE TRAIL THROUGH THE RAIN FOREST BENEATH THE MOSS, BESIDE THE FERNS.

THE FERNS OF THE RAIN-FOREST

By CLIFFORD H. FARR, Ph.D.

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THE marvel of the vegetation of the tropical rain-forest is the tree-fern. A tree in form and size and a fern in structure, this plant has been indeed aptly named. Its stem stands erect in the midst of the jungle to a height of fifty feet in some instances, and its few large leaves form a crown at the top very much like that of the palm. But tree-ferns are even more beautiful than the royal palm, the most stately of that group. The leaves are more finely divided, delicate and lace-like, and are arranged in a perfect rosette; and the stem, far more slender and graceful, has its surface moulded into a unique pattern as if in terra cotta.

Tree-ferns are exceedingly choice in selecting their dwelling places, and refuse to endure any sort of rigorous environment. In fact, they grow in the most evenly tempered climates in the world. The average temperature of their habitat in Jamaica is about sixty degrees Fahrenheit, and no variation of

THE LARGE-LEAVED *Alsophila pruriata*.



LOOKING UP A RAVINE.
Climbing Ferns to the right.

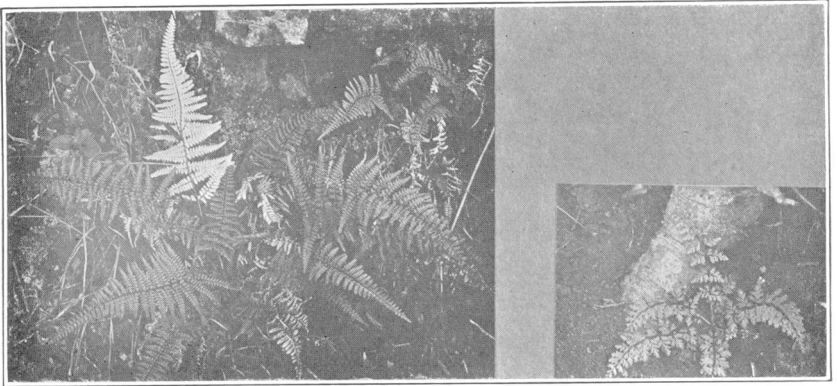
more than sixteen degrees above or below occurs throughout the entire year. There are thus no cold winters nor hot summers with which to contend; and likewise there are no long periods of drought usually, for the tree-fern grows where it rains almost every day. The moisture-laden trade winds strike against the north side of the Blue Mountains of Jamaica at an elevation of about one thousand feet and slowly creep up their slopes, the moisture precipitating as it cools. It is on such slopes as these, at an altitude of about five thousand feet, that the tree-fern is at its best. Here the minimum annual rainfall is about sixty inches and the maximum about two hundred. Not only does the tree-fern require a very moderate temperature and a large amount of moisture both in the soil and air, but it is also not adapted to withstand strong winds. Its slender, unbranched stem, only two or three inches thick and many feet in height, is extremely frail in comparison with the trunks of other trees. Consequently, it must hide itself in the

depths of narrow ravines through which only gentle zephyrs move. Nor does the direct intense light of the tropical sun usually fall upon most members of this group through long periods, for other trees and perpetually veiling clouds shield them from its actinic rays. Despite the fact that light is an essential to plant activity, these curious forms, unlike other trees, do not continue to flourish when direct sunlight strikes them day after day. It is probably not the light of the sun, but rather the heat which does injury to these plants. Long before the engineer discovered that heat rays might be separated from light rays by interposing a water screen, these ferns were enjoying the beneficent activity of the ever-present clouds in absorbing the thermal portion of the solar radiation while transmitting a large proportion of its light.

In fact, the tree-fern lives under very nearly perfect conditions from the standpoint of a plant. There must be moderate uniform temperatures, abundance of soil moisture, high humidity, freedom from strong air currents, and a maximum amount



WALKING FERN WITH DROP OF WATER ON TIP.



The Silver Fern.

The Golden Fern.



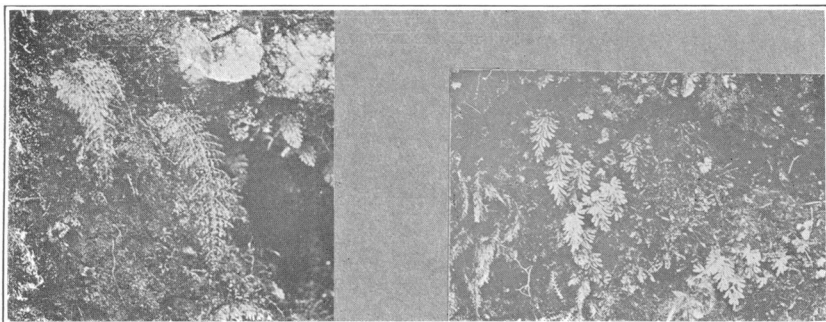
The Black Fern.

Like the Wings of a Bird.

FERNS OF MANY FORMS AND COLORS.

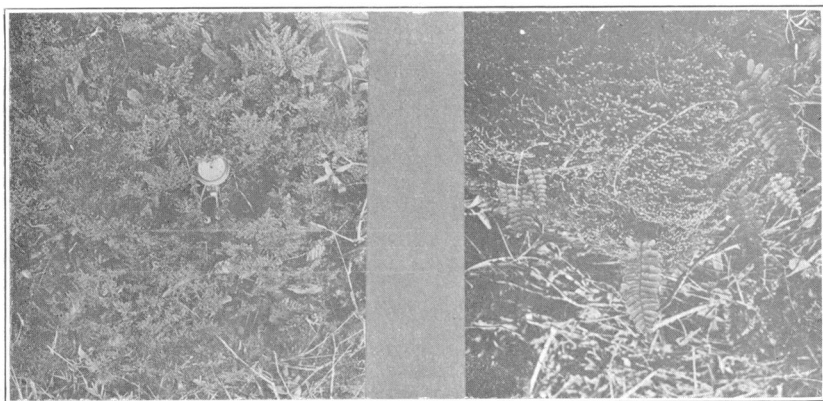
of light. Only the mountain rain-forest of the tropics can afford this ideal combination of environmental factors. Here of all places is the paradise of ferns. Ferns carpet the floor of the forest and the walls of the steep-sided ravines. There are walking-ferns with the tips of their leaves projecting into a long beak, curled at the end. Water repeatedly falling collects in a drop on this little curl, and within this drop of water a bud develops. As this bud increases in size and weight, the leaf bends over, finally touching the ground where the new plant can start life independently.

Then there are black ferns, the backs of their leaves densely covered with black reproductive bodies, known as spores. There is the silver fern too, but the white color of the under surface of its frond is due to air within and among the minute hairs which grow there. A similar cause is responsible for the gilded appearance of the under side of the leaf of the golden fern. Some ferns are very harsh and form dense, almost im-



The most delicate.
Hymenophyllum polyanthos.

The smallest.
Hymenophyllum fucoides.



On a Moss-covered Log.
Trichomanes crispum.

Lacelike though sharp and harsh.
Trichomanes rigidum.

FILMY FERNS.

passable thickets; such are the hogferry, rambling fern and certain species of forked ferns. Others climb the trunks of trees, or perch on the branches. But the tree-fern, the aristocrat among them, stands head and shoulders above all its kinfolk, both in stature and in esthetic grandeur.

In the old world tree-ferns are distributed between 47° south and 32° north latitude; a few are found in the extreme southern portion of Japan. They are most abundant, however, in Australia and the Pacific Islands, though fairly numerous in Ceylon, Java and New Zealand. The starchy pith of some of the New Zealand species is used as food, or is fermented and shipped to India, where it is consumed as an intoxicating beverage called "Ruckschi." In the western hemisphere their range is more limited, from about 44° south to 25° north latitude. The Hawaiian Islands and the Antilles, the Andes and Central America have many forms, but they especially abound



FERNS OF MANY SIZES BY THE WAYSIDE.

on the island of Jamaica. Dr. Forrest Shreve has made a special study of climatic conditions in their habitat in Jamaica, and his interesting results were published by the Carnegie Institution of Washington in 1914.

Tree-ferns belong to a single family known as the Cyatheaceæ, of which there are about two hundred species. Not all of these species, however, are tree-ferns, but many have a horizontal stem, as do ordinary ferns. These two hundred species are grouped into four genera: *Cyathea*, *Alsophila*, *Dicksonia* and *Hemitelia*. Of the last-named genus the tallest is *Hemitelia Smithii*, growing in New Zealand to a height of less than twenty feet. *Cyathea* reaches its greatest development in Jamaica, where the stems of two species, *furfuracea* and *pubescens*, may measure more than forty feet. The maximum height of *Dicksonia* is attained in Australia, where *Dicksonia antarctica* is found at times to be at least sixty feet. In this same region grows the tallest of them all, *Alsophila excelsa*, which has been reported to lift its crown as much as eighty feet above the ground.

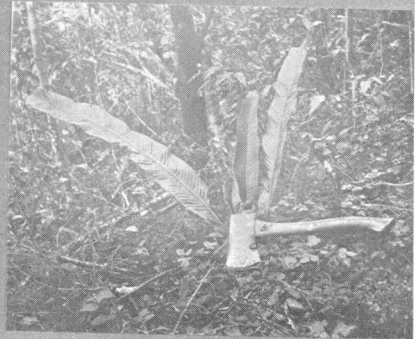
The stems of tree-ferns rarely branch. When they do, it is not a branching at right angles, but a dichotomous forking of the main stem, resulting in two crowns of leaves. In some species the leaves remain attached to the stem after they have died, completely hiding it. Usually, however, after the work of food-manufacture and spore-formation is finished the leaf breaks away, leaving a scar which may be a half inch or more in diameter. It is slightly oval and, like a cameo, elevated above the surface of the stem. Every leaf-scar has markings symmetrically arranged in some sort of pattern characteristic of the species. These markings are a series of pores or tubes through which water was carried upward to the leaves and food materials downward to the roots. In *Cyathea furfuracea* a circle of twenty of these ducts, equally spaced, lies just inside the margin of the leaf-scar. Within this circle is a smooth triangular area bounded by eight more pores, the apex of the triangle pointing downward.

These scars are arranged in seven longitudinal rows up and down the stem, slightly winding about it in a sort of loose spiral. This spiral is undoubtedly brought about by the torsion of the stem during growth, the rigidity of the stem being so great that it could not have been twisted after once being formed.

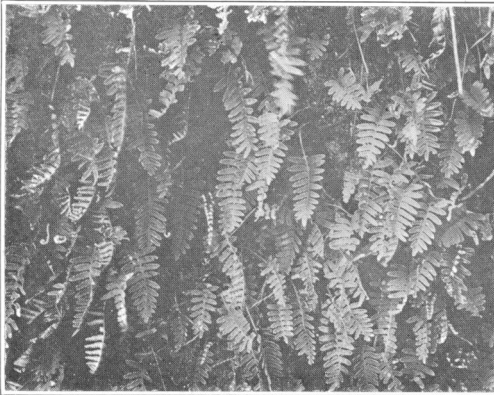
The area between the leaf-scars is covered with two kinds of structures: the ramentum and the roots. The former, characteristic of most ferns, consists of brown chaff-like scales an inch or more in length. They envelop the young leaves and roots, protecting them in their early stages. In all ferns the



The Smallest
Mixed with Spongy Lichens.



The Largest.
Pessopteris crassifolia.



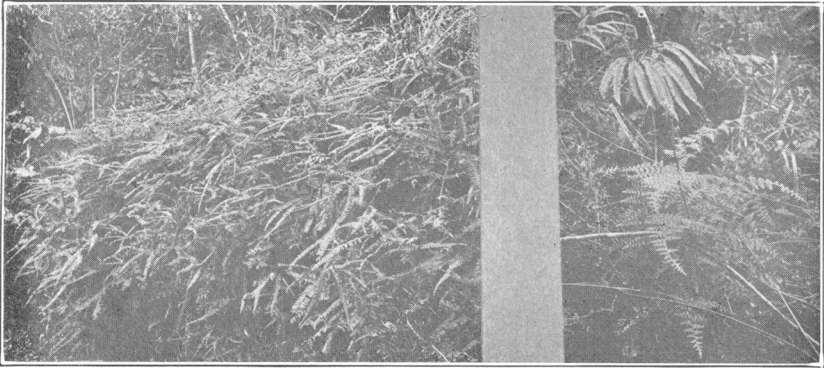
Hanging over a Rocky Cliff.
Note fruit-dots on under surface.



Rambling over the Rocks
amidst the Strawberry Leaves.

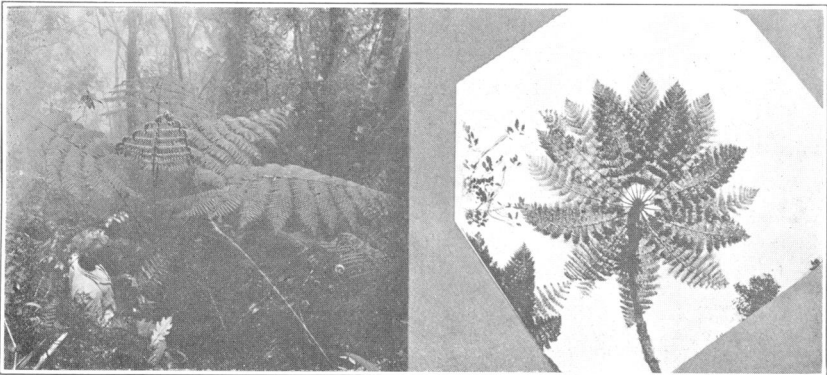
ENTIRE-LEAVED FERNS AND A *Polypodium*.

roots grow out between the leaf bases. The tree-fern thus has no tap root at the base of the stem, nor is the latter deeply sunken in the ground; hence, the necessity for tree-ferns to avoid windy places. The lower end of the stem is located almost on the top of the ground and the only means of support and anchorage are the numerous small roots which clothe its base. They are of about uniform diameter, rarely exceeding a fifth of an inch, and about twenty or thirty are produced around each leaf base. As the stem grows progressively upward, new roots are formed between the new leaf bases and grow down over the roots below, weaving in and out among them, forming



A Thicket of *Dicranopteris*.

Two Species of
Dicranopteris, and a
Bracken fern below.



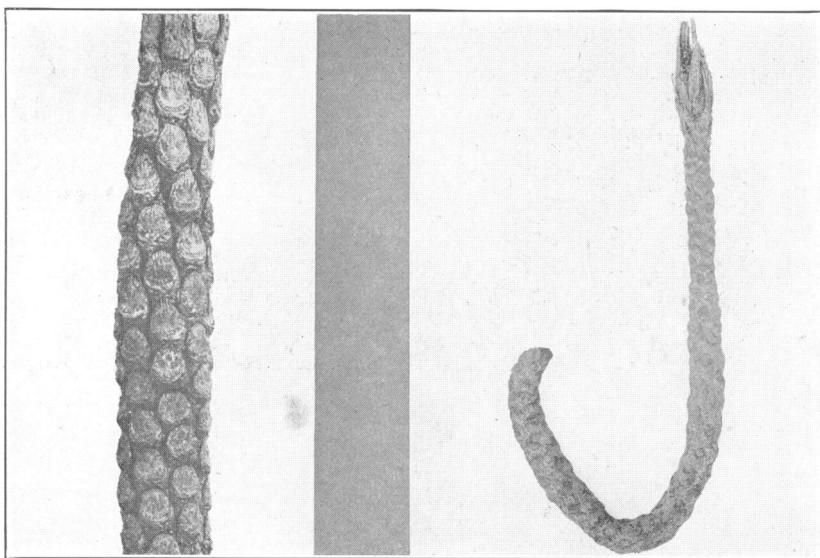
A Thorny Vine,
Odontosoria jenmanni.

A *Dicranopteris pectinata*,
showing the forking.

FORKED LEAVES AND RAMBLERS.

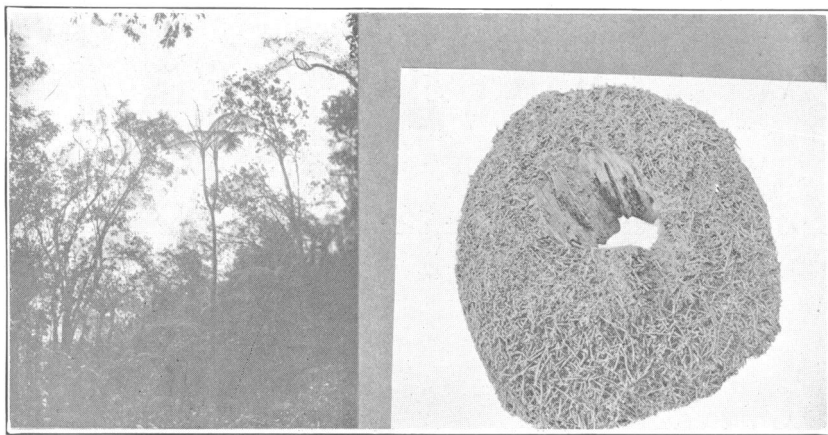
a compact entanglement, which at the base of the tree may become several inches thick.

This curious method of root development gives rise to some very interesting features in the life of this plant. The older roots, as well as the base of the stem, die, though they do not decay, so that the water for the leaves is carried by the younger roots for several feet above the ground on the outside instead of the inside of the stem. There is thus a greater amount of moisture required in the soil and in the air to compensate for the loss which is undoubtedly involved in the great exposure of the conductive tracts. On the other hand, this is an ingenious means of multiplying the number of conductive tubes, in the absence of cambium, to enlarge the stem. Furthermore, by the continued formation of new roots, the older ones may be dis-



Leaf Scars.

Crooked by tumbling.



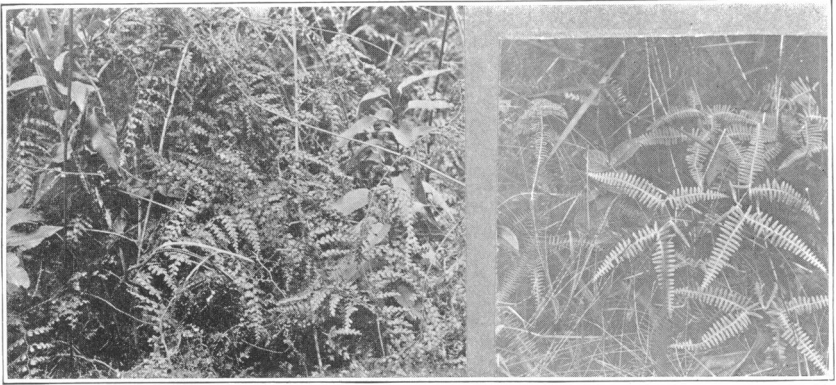
Rarely does it fork.

The roots that clothe the base.

THE STEM OF THE TREE-FERN.

carded as soon as they cease to function without impairing the supply of water to the leaves. At the same time, the dead tissue of the roots and stem is utilized for support and for protection of the new roots.

Another beneficial feature of this mode of development of roots is shown when an accident has befallen the plant. Tree-ferns are especially liable to fall, both because of their slight anchorage and the great erosion due to the steepness of the slopes and the almost incessant rainfall. When a tree-fern falls



The Spreading Level Leaves.

The Silhouette against the clouded sky.



The Monarch of the Jungle.

Forty feet above the Soil.

THE CROWN OF THE TREE-FERNS.

upon its side, the new growth takes place in a vertical direction, forming an angle with the fallen portion. The new roots pass directly into the soil, leaving the prostrate portion of the stem entirely useless. The accompanying photograph shows a stem to which at least three such mishaps had occurred. When the writer found it, the base of the stem was projecting away from the soil, and only a few weak roots were keeping it from rolling still farther down the hillside.

The leaves of tree-ferns are always quite large. In *Alsophila pruniata* they frequently measure sixteen to eighteen feet, forming perfect arches beneath which one may walk without disturbing a single leaflet. The main axis of some of the fronds of a South American species are said to be as much as eighteen



THE ZONE ALONG THE MOUNTAIN'S SIDE.

meters, but this statement may be an exaggeration. The rachis bearing the leaflets may branch as much as six or seven times. Upon the under surface of these leaflets are borne the reproductive bodies, or sori. In *Cyathea* these are tiny smooth brown spheres within which are the numerous sporangia containing spores. In *Hemitelia* the sorus is cup-shaped, more than filled with sporangia. In *Dicksonia* it consists of two valves operating on a hinge. In *Alsophila* there is no covering for the sporangia which are simply grouped together in spherical clusters.

The young leaves are rolled in the bud in the form of a watch-spring, which is sometimes several inches in diameter. The inner coils are almost completely veiled from view by the chocolate-colored hair-like ramentum. The leaf gradually unrolls and each of the secondary branches is likewise seen to be coiled. Thus there comes to be a coil on the end of the main rachis and on each of its lateral branches. The growing tissue is within this coil and from it all parts of the leaf are produced. The strengthening tissue is the last to appear and, consequently, the coil hangs pendant from the tips of the leaf, giving the whole a drooping, wilted appearance. During the unrolling of the leaf the rachis is almost vertical, but as it grows older it bends more and more toward the horizontal. When this position is reached in most species the spores are shed, and then the leaf continues to bend downward, finally dropping off. This procedure is very similar to palm leaves, though the latter have no spores, and the leaves are formed singly. In the tree-fern there is a rosette of four or more passing through the series of changes simultaneously, and followed somewhat later by another set. Sometimes two or three sets may be seen in different stages at the same time.

It is a beautiful sight to behold, from the hillside above, these huge crowns with their delicate lacelike leaves, the leaflets all turgid and in a single plane. But the master picture is for him who looks, not earthward, but heavenward. As you walk through the jungle your eyes glance upward and behold a wonderful vision, a symmetrical silhouette of the enormous rosette against the soft background of the clouded sky. The fronds radiating from the apex of the stem like the points of a star present a distinctly artistic pattern. Go to the art institutes and museums of the world, you can not match this. This was modeled by a sculptor whose touch is infinitely more delicate than the clumsy fingers of the most skilled of human artists. Silently you marvel at the splendor, and with Browning,

Look through Nature, up to Nature's God.